

SCIENTIFIC WRITING

The requirements for writing a report, essay and literature review have been provided in the First Year Skills booklet and you should be fairly proficient in these styles by now. In Intermediate courses you will need to further develop your mastery of these styles and take time to develop an appropriate scientific style of communication. Brief notes on writing a practical report, an essay and a literature review are given in later sections of this manual. The following section on *Scientific Writing* is more related to the effective use of English and gives details on general scientific writing style, scientific conventions and grammar.

Using the English language to successfully communicate scientific findings does not come easily to most people. Choosing the correct words and using correct grammar are skills now rarely taught in schools, so many University students are at some disadvantage. The following notes are designed to encourage you to think more carefully about how effectively you write and to give you an introduction to the format and conventions required for different types of written scientific works. There are a number of questions, written in italics, throughout the text. You should answer these as you work through the notes. Answers to certain questions are available at the Generic Skills Website.

1. INTRODUCTION

Good research is meaningless unless you can communicate your findings in a clear and interesting fashion. The days in which scientific papers were works of great literature is past but we can still strive to make our writing informative and worth reading. Woods (1989) writes ‘The purpose of any writing other than lecture notes or pieces that start with “Dear Diary” is to influence your reader. If you are writing great fiction you may move your reader to tears. This can also happen with scientific writing, but generally you do not want to make your reader weep.’ (We hope this does not happen when we mark your essays!)

The importance of good writing cannot be over-emphasised. In many cases the written word is the only means by which scientists communicate and it is the main way in which students communicate with and are assessed by their teachers. The table below provides a few published thoughts by University lecturers:

‘...for a student to succeed in a science course, and to become an adequate scientific practitioner, [they] must have better expression skills than are necessary for almost any other course or vocation. Vagueness, ambiguity and inability to express clearly and succinctly are intolerable in a scientist.’ (Towns, 1990)

‘Offer me a choice: two [University] entrants of the same IQ (if such a measure can, for a moment, be accepted as valid). Both have natural curiosity about science,¹ and sensible ambition. One has inadequate chemistry but good literacy skills, the other the converse. Which do I feel has the greater chance, given strong motivation, of succeeding in a science degree and beyond? Well, I shall take the literate one. Those who disagree with me are quite welcome to the other.’ (Towns, 1990)

‘The fundamental purpose of scientific discourse is not the mere presentation of information and thought, but rather its actual communication. It does not matter how pleased an author might be to have converted all the right data into sentences and paragraphs; it matters only whether a large majority of the reading audience accurately perceives what the author had in mind.’ (Gopen and Swan, 1990)

Whether you are writing an essay, literature review or the discussion in a practical report, you will have the task of presenting a logical series of facts and reasoned argument to your reader. Your sentences and paragraphs should be in a logical order so that the reader can easily follow your argument and reach the same conclusion you have. Each paragraph should be able to stand on its own and be internally cohesive. A long piece of writing can be made more readable if you use subheadings to organise the prose into sections. Be cautious about writing the first phrase that comes into your head and get into the habit of writing several drafts of any report or essay.

You want your reader to understand what you are writing, to maintain respect for you and not to become annoyed with you. This can be done if you write simply, succinctly and without grammatical errors. Correct spelling is also a great help!

A note on computer spellcheckers

Correcting a final draft of a piece of writing is not something that can be left to the efforts of the spellchecker in your word processing program. They are useful for a first scan of your work but they are not infallible and will miss many errors, for example:

- if you have used **there** instead of **their**, the spellchecker will not recognise it as a mistake as the words are correctly spelt;
- if you have typed **the** instead of **then**, the Spellchecker will ignore it as **the** is correctly spelt.

Remember to select an English/Australian dictionary in your word processing program, especially if you use Autocorrect, so that American spellings are not accepted in your work. (Note that some computer ‘Australian-English’ dictionaries accept American spelling. The words center, hemoglobin, anemia, and color are NOT English.) See Appendix 1 for a cautionary tale about Spellcheckers.

N.B. If you use computers on campus or you are connected to the University of Sydney server from your home computer you can access the Complete Oxford English Dictionary at <http://setis.library.usyd.edu.au/oed/>.

¹ Refer to the Generic Skills Website, Tip of the Week, for discussion of the “Oxford comma”.

A note on computer grammarcheckers

Hmm! Several years ago I would have suggested that you not waste your time with them. However, they have improved recently and are useful for picking up repeated words, non-sentences, multiple spaces between words and my favourite, the correct usage of ‘that’ and ‘which’. (See entry under 3.2 *Common errors of word usage*.)

2. TYPES OF SCIENTIFIC LITERATURE

‘Keeping up with the literature’ is a common obsession of successful scientists. That ominous phrase ‘the literature’ generally refers to the published journal and review papers on a particular subject.

2.1 Journal papers and practical reports

A **journal paper** reports the results of original research. As an undergraduate you will be required to write reports on laboratory and fieldwork; these correspond in purpose and style to journal papers. You have received instruction on how to write a laboratory report in First Year and there are further instructions on report writing later in this manual. See also pages 63 - 68 of Lindsay (1984).

2.2 Literature reviews and essays

A **review paper** presents the previously published facts and theories in a particular field but is more than a mere catalogue of previous literature. A good review is a critical summary or synthesis of the current knowledge in that field. It should highlight areas in which further research should be carried out and should stimulate readers to carry out this research. It should point out any deficiencies or inaccuracies in previous research. The author of a review is free to use his own interpretation and opinion, *e.g.* ‘I believe Brown (1980) is mistaken because ...’. Such interpretations must be supported by sound reasoning (note the word ‘because’) and normally result from years of experience in the field.

As an undergraduate you will write essays or literature reviews, which correspond to review papers. You do not have the experience of the average review author but it should still be possible to inject some originality into your review, rather than just presenting a catalogue of facts. You can reassess the conclusions of the original authors in the light of more recent knowledge and compare and contrast the results and conclusions of different authors.

3. WORDS

3.1 Save trees! (and eschew terminological obfuscation!)

‘Use words with precision and economy to construct sentences that are exact, clear and as simple as the subject permits.’ CBE Style Manual.

Many students have a tendency to write in a flowery fashion and use many more words than are really necessary in order to tell their reader what they want to say. The previous sentence, for example, could be written: Many students use flowery language and more words than necessary to say what they want. There are no extra marks for writing long-winded, convoluted sentences, or using seven-syllable words. In scientific writing only your ability to communicate clearly is on trial. Compare the following lists of wordy and concise statements:

Wordy	Concise
... if conditions are such that	... if
... in order to	... to
... there can be little doubt that this is	... this probably is
... plants exhibited good growth	... plants grew well
... bright green in colour	... bright green
... by means of	... by/with
... created the possibility	... made possible
... due to the fact that	... because
... fewer in number	... fewer
... for the reason that	... because, since
... in all cases	... always
... in view of the fact that	... since, because
... it is often the case that	... often
... it is possible that the cause is	... the cause may be
... it would appear that	... apparently

In the early twentieth century, W. H. Fowler was commissioned by Oxford University Press to write a book on English usage. He and his brother Frank had previously produced *The Concise Oxford Dictionary* and *The King's English*. Following his brother's death, W.H. Fowler proposed to his publisher that he write an 'idiom dictionary', for the 'half-educated Englishman of literary proclivities who ... has idioms floating in his head in a jumbled state and knows it.' The project was eventually accepted and the book was published in 1926 as *The Oxford Guide to Modern English Usage*. It is still regarded as the final word on grammar and word usage. Fowler formulated five simple rules as a starting point for good writing; more recent authors have modified these rules and they can be summarised as follows:

Prefer the familiar word to the unfamiliar word

(e.g. 'linkage' rather than 'concatenation')

Prefer the concrete word to the abstract word

(e.g. 'Investigate' rather than 'Make an investigation into')
(verb) (noun)

Prefer the active voice to the passive voice

(e.g. 'Our experiments show' rather than 'It has been shown by our experiments')

Prefer the single word to the round-about phrase

(e.g. 'because' rather than 'due to the fact that')

Prefer the short word to the long word

(e.g. 'orient' rather than 'orientate')

The rules are in order of merit and the second and third make a similar point. Fowler's final rule was to prefer the Saxon word to the Romance; however recent authorities suggest that strict adherence to this rule would beggar the richness of the English language.

Question 1. Rewrite the following sentences using as few words as possible.

(a) It is generally thought that the most common reason for the difference in experimental results in biological experiments can be said to be due to the large amount of variability between individuals of any population that is being studied.

(b) The question of whether or not students should be expected to pay tuition fees continues to be under debate.

(c) Use a great deal of care to ensure that your fingers do not come into contact with the bunsen flame.

The references provided (end of section 8) contain many more examples but the message is the same: your first thought or written sentence will usually be more wordy than necessary, so read critically and remove words and phrases that are not essential.

3.2 Common errors of word usage

Good communication in science requires exactness. The following words are often confused. Learn the differences between them (or suffer the wrath of your lecturers and demonstrators!). Consult the glossary (section 9) for the meanings of grammatical terms.

Affect and effect

These two words have very different meanings and are regularly misused.

Affect is a verb. *e.g.* **Stomatal closing affects the temperature of a leaf.**

Effect is (in most cases) a noun. *e.g.* **Stomatal closing has a significant effect on leaf temperature.**

There is one case in which **effect** is used as a verb: when it means ‘to cause or bring about’, as in **to effect a change**. If you have trouble with the distinction between these two words refer to any of the references on usage. (Any student guilty of their misuse will be severely penalised and held up for general censure.)

Alternate and alternative

Alternate = ‘occur or arrange by turns’. *e.g.* TV programmes during the non-ratings period alternate between awful and terrible.

Alternative implies that a choice is possible. *e.g.* The alternative to watching these appalling programmes is to hire videos.

Consist of and comprise

Consist(s) takes the preposition **of** but **comprise(s)** does not. *e.g.* A virus **consists of** a core of nucleic acid and a protein coat; Your Intermediate classwork **comprises** lectures, practicals and tutorials.

(Use **comprise** only when ALL of the components are listed - if they are not, then use **include**. *e.g.* in the statement **Your Intermediate classwork includes lectures and practicals**, **comprise** would be incorrect.)

Less and fewer

Take note our illiterate politicians!

Less = ‘a smaller amount of’ and takes a singular noun.

e.g. **There is less work available during a recession.**

Fewer = ‘a smaller number of’ and takes a plural noun.

e.g. **There are fewer jobs available during a recession.**

From Column 8 ‘An ex-teacher of Turrumurra sympathises with her former colleagues’ problems but wishes they would be a bit more careful with their advertising stickers. ‘Less teachers, pupils suffer’ was what she read on a Commodore window at Fairfield. ‘Fewer, please,’ she pleads.’

It’s and Its

It’s is the contraction of **it is** or **it has**. **Its** is the possessive pronoun and has no apostrophe.

e.g. **It’s a long way to the top’; The garden snail gets its helical shape through the process of torsion.**

Similarly the possessive pronouns **hers**, **ours** and **yours** have no apostrophe.

That and which

Use **that** at the beginning of a defining (restrictive) clause. (See glossary)

e.g. **Each student should write a list of the references that they used in their essay.**

The clause **that they used in their essay** defines a particular set of references. It is not separated from the main clause by commas.

Use **which** for a non-defining (non-restrictive) clause. (See glossary)

e.g. **Students should refer to a large number of references, which are found in the library.**

The clause **which are found in the library** simply provides further information about references in general. It is separated from the main clause by commas.

(To anyone who has a copy of Burchfield’s revised edition of Fowler’s Modern English Usage, which allows the use of **which** in a defining clause, I would recommend burning it at once.)

Note that **who** replaces **that** and **which** when you are referring to particular people. The rule about placing a comma before a non-defining clause remains the same (refer to the doctor example in the glossary.)

There, their and they’re

Compare the following:

There is a house in New Orleans ...’

Their house is in New Orleans.

They’re (they are) living in a house in New Orleans.

Shall and will, should and would

Shall and **should** express obligation. **Will** and **would** express determination or resolve.
e.g. **He should be more careful. You would say that!**

(Legend has it that a Scotsman once drowned because he cried 'I will drown and no-one shall save me' and the Englishmen on the bank took him at his word!)

Many pages in formal usage texts are devoted to the distinction between the use of **shall** in the first person and **will** in the second and third person to express simple futurity (1 and 2) or as an auxiliary (3 and 4).

e.g. **1. I shall go. 2. You/he/she will go. 3. I should like to thank you. 4. He would like to come.**

In common practice it is now acceptable to use **will/would** for all persons and using **shall** and **should** is considered archaic by some authorities. The first person **should** must still be used for formal writing, especially in formal correspondence. (Remember this if you write to the Queen's private secretary.) (On no account may you address any letter to the Queen personally.) (Debrett's Correct Form)

Various, varying and variable

Various means 'of several kinds'. **Varying** and **variable** imply changing from one kind to another.

e.g. **Nets of varying mesh size are used to collect different sized organisms from plankton** implies that a net is capable of changing its mesh size, and is incorrect.

Problematic plurals

The word **data** is plural. *e.g.* **Data are tabulated in Fig. 1.** The singular is **datum** and is rarely used.

* **Bacterium** is singular. *e.g.* **The bacterium *E. coli* is the microbiologist's white rat.**
The plural is **bacteria**. *e. g.* **Bacteria are killed by various antibiotics.**

* **Medium** is singular. *e.g.* **The bacteria were cultured in a nutrient medium.**
The plural is **media**. *e.g.* **Several different media were used to culture different strains of bacteria.**

* **Phenomenon** is singular. *e.g.* **An interesting phenomenon.**
The plural is **phenomena**. *e.g.* **These phenomena are odd.**

* **Criterion** is singular, meaning 'standard by which something is judged.' *e.g.* **One criterion for success is...**
The plural is **criteria**. *e.g.* **The criteria for awarding the prize are ...** (Note the form of the verb 'to be' in each case.)

* The plural of **taxon** is two or more **taxa**.

* The plural of **genus** is two or more **genera**.

* The plural of **phylum** is two or more **phyla**.

* **There is** and **There are** are frequently misused. **There is** or **There's** can only precede a singular entity. *e.g.* **There's several reasons ... incorrect!** This should be written **There are several reasons ...**

(Note: **'There's too many of you** (Temple scene, *Jesus Christ Superstar*) is incorrect!)

No-one in the Australian media knows the distinction between these two forms, especially advertisers. Listen carefully the next time you turn on the television or the radio and be appalled!

Words and phrases to avoid

being; though; furthermore; in addition; Firstly, Secondly, Thirdly at the beginning of a series of sentences. (I have read some student writing in which every sentence in some paragraphs begins with furthermore.)

Read on

This is not an exhaustive list, merely some of the very worst offenders. Fowler (1965), Gowers (1986), Partridge (1973) and the *The Oxford Miniguide to English Usage* include extensive lists of similarly confused words and they make fascinating reading. If you are in any doubt at all about the correct usage of words you are using then look them up in any (or all) of these references. Check the Generic Skills Website for further advice and links to English usage sites.

3.3 Scientific conventions and nomenclature

Use of *italics*

Specific names of organisms are written using a capital letter for the genus name (*Homo*) and a small letter for the species name (*sapiens*). Italics are used for specific names in printed works, but in handwritten reports the entire specific name should be underlined. Do not underline any other taxonomic name (such as class and family names).

e.g. The fat-tailed dunnart, *Sminthopsis crassicaudata*, is a member of the Family Dasyuridae.

Or: The fat-tailed dunnart, *Sminthopsis crassicaudata*, is a member of the Family Dasyuridae.

Italics (or underlining) are also used for foreign words, especially Latin terms such as *in vivo*, *in vitro*, *a priori*, *exemplia gratia* (*e.g.*), *id est* (*i.e.*), *etc.*

(N.B. Some journals require the common names of species to be written with a capital letter [*e.g.* the Koala] but there is no absolute convention for this.)

Taxon names and common names

All names of taxa above the rank of genus should start with a capital letter. If the name of a taxon is used as a common name then it starts with a lower case letter. *e.g.* **Phylum Platyhelminthes, platyhelminths; Phylum Annelida, annelids; Class Malacostraca, malacostracans; Phylum Crustacea, crustaceans.**

The endings of taxon names are standardised, although the standards are different for zoological, botanical and bacteriological taxa. In the Zoological Code, superfamily names end in **-oidea**, family names in **-idae**, and subfamily names in **-inae**. *e.g.* Superfamily Vombatoidea, containing the Families Vombatidae and Phascolarctidae. Phylum, class and order names have various endings, although many end in **-a**. In the Botanical Code, class names end in **-ida**, order names end in **-ales**, and family names end in **-aceae**.

Abbreviations

If you wish to use an abbreviation for a chemical or generic name, write the full name the first time it appears in the text. *e.g.* **Glyceraldehyde 3-phosphate is converted to 1,3-diphosphoglycerate (1,3-DPG)**. Henceforth in the same manuscript you can simply refer to 1,3-DPG (unless it is at the beginning of a sentence). The second time you refer to the fat-tailed dunnart you can use *S. crassicaudata*. Never abbreviate the species part of a scientific name (*i.e.* you must always write *crassicaudata* in full).

Do not use an abbreviation at the beginning of a sentence. Avoid using abbreviations in a summary or abstract, unless the same expression is to be used several times within the summary itself. You should also avoid using contractions such as don't, can't, wasn't, *etc.* in scientific works.

Numbers and numerals

Always write the full word for single digit numbers (*e.g.* **five**, not **5**). For double-digit numbers, write the numerals (*e.g.* 35, 287).

4. SENTENCES

The Shorter Oxford English Dictionary defines a sentence as 'a series of words in connected speech or writing, forming the grammatically complete expression of a single thought.' A sentence must contain a subject and a verb that directly relates to the subject. More formally this definition is expressed as a subject and a predicate, where predicate refers to what is said about the subject.

Subordinate clauses - or how to write a non-sentence

A **common error** is to mistake a subordinate clause (containing a verb) for a complete sentence. A subordinate clause (preceded by words such as that, which, who, if, although) provides extra information about the main clause and cannot exist on its own as a complete sentence. (See the glossary for further information on clauses.)

e.g. **The birds that migrate to southern Europe, where the climate is milder.** is not a sentence. It does contain verbs but neither of them directly relates to the subject of the sentence - **The birds**. Compare the true sentence **The birds migrate to southern Europe, where the climate is milder.** in which the verb **migrate** directly relates to the subject.

A good way to check that you have written a true sentence is to read it without the subordinate clauses and check whether it makes sense. In the first example above, the clause **that migrate to southern Europe** defines the birds and the clause **where the climate is milder** gives more information about southern Europe. If you leave out these clauses it reads **The birds.** and this is clearly not a sentence. In the second example, the shortened sentence reads **The birds migrate to southern Europe.** and this is a true sentence.

Though and **although** precede a subordinate clause and that clause alone does not constitute a sentence. e.g. **Though it looked like rain.** is a non-sentence.

Question 2. (a) *Which of the following are true sentences?*

(b) *Rewrite any 'non-sentences' to make them true sentences.*

(i) *The forest ecosystem that is currently under threat from logging, vandalism and the impact of feral cats and foxes.*

(ii) *The sheep rumen contains large populations of protists, fungi and bacteria, which break down cellulose.*

(iii) *Although the experimental conditions were optimal.*

Keep your subordinate clauses close to the subject. A classic example of misplaced clauses is: **Rugby is a game played by men with funny shaped balls.** And this was written in a New Zealand train timetable: **The carriages are comfortable, fully carpeted and are equipped with wool-covered seats featuring large panoramic windows.** Similar confusion can be created by ordering adjectives in the wrong way: owners of a koala sanctuary asked readers of Column 8 to send them 'used women's stockings' to tie up their sapling eucalypts. The editor agreed to print the request provided the wording was changed to 'women's used stockings'.

The present participle - or how to write a non-sentence

The following examples illustrate a common student error - that of using the present participle (that's the verb form that ends in 'ing') in place of the present or past tense.

e.g. **The blue whale being the largest mammal on Earth.** (should read **The blue whale is the largest mammal on Earth.**)

My advice is if you have used (or have the slightest inclination to use) a verb ending in 'ing' in your writing then BEWARE. Take some time to ensure that the sentence makes grammatical sense. ASK ME if in doubt! Let's refer back to the definition of a sentence, as containing a subject and verb that directly relates to the subject: **being the largest mammal on Earth** is a subordinate clause and the word **being** does not relate directly to the subject (**The blue whale**).

Verb agreement - or how to write a nonsensical sentence

Do not write sentences that are so long that the reader loses track of the main point. Split any such sentence into smaller ones. Keep the subject and verb close together, as this will help you to avoid errors of tense and of verbs not agreeing with their subject.

Question 3. *What is wrong with the following sentence? Rewrite it (using more than one sentence) to make it grammatically correct.*

The lion, which lives in Africa where it is greatly feared by the natives and which feeds on kudu, eland, gnus, wildebeeste, zebras and a wide variety of other animals, which are usually stalked and killed by the lionesses, are savage.

5. PUNCTUATION

“But I know how to use punctuation!” I hear you cry. To use that immortal line from the movie *Betrayal*, I would reply: “Are you sure?” Here are a few brief and very introductory pointers on correct punctuation. Refer to any of the suggested references on usage [in particular pages 152 - 175 of Gowers (1986) or pages 587 - 592 of Fowler (1965)] for more detail. Used wisely, punctuation makes your prose readable. However, do not fall into the trap of using punctuation as an excuse for poorly structured sentences.

Stops

Stops are used to break up your prose. In order of increasing strength they are the comma, semicolon, colon and full stop.

Comma (,)

‘The correct use of the comma - if there is such a thing as “correct” use - can only be acquired by common sense, observation and taste.’ (Gowers, 1986). This immediately poses a problem for the average undergraduate student, who may not possess any of these qualities. A good rule is to use a comma only if your meaning would be unclear without one. Another useful technique is to read your work aloud and use a comma where you pause for breath. If any sentence you write contains more than four commas, reword it or break it up into smaller sentences.

A **common error** is to use a comma where a firmer stop (fullstop, colon or semicolon) is required, thus running several sentences together so they read as nonsense.

e.g. **The words significant difference refer to the results of statistical tests, you should therefore use them discriminately.** Incorrect! Use a conjunction (**and** or **so**, deleting **therefore**) or separate the two parts by a semicolon or fullstop.

If you use commas to insert parenthetical phrases, be careful to correctly place **both** commas.

e.g. **It is useful when recording references, to write each one on a record card.** Incorrect! (Place a comma after **useful** or omit all commas.)

Authors have different preferences for placing a comma after the second last item in a list and there is no absolute rule for this. *e.g.* **Little girls are made of sugar, spice and all things nice** vs **Little girls are made of sugar, spice, and all things nice**. The comma preceding the last item in a list is called ‘the Oxford comma’. I would recommend not using the comma unless it is necessary to clarify groupings.

e.g. **Annelids were classically divided into three groups: polychaetes, clitellates, containing the leeches and earthworms, and the group comprising pogonophorans and vestimentiferans.** (Also consider how useful the Oxford comma would have been to the author who dedicated her book ‘to my parents, Ayn Rand and God’.)

Do not use commas to parenthesise a defining (restrictive) clause. (See glossary)

e.g. **Students, who are lazy, will obtain poor results.** Incorrect!

(This sentence says all students are lazy. Without the commas [correct] the sentence would describe what happens to certain students [the lazy ones] only.)

Do not use commas to separate two main clauses, each of which could stand alone as a complete sentence. *e.g.* **We went to the beach and played volleyball.** (No comma after **beach**.) (Note that when joining two main clauses the subject need not be repeated - see glossary)

Semicolon (;)

Use a semicolon:

(i) to divide a sentence, when the two parts are too closely related to be separated by a full stop.

e.g. **Biological evolution may be slight or substantial; it embraces everything from slight changes in the proportion of different alleles within a population (such as those determining blood types) to the successive alterations that led from the earliest protoorganism to snails, bees, giraffes, and dandelions.** (Futuyma, 1987).

(ii) to separate members of a list when the members are long, or contain their own commas.

e.g. **The major tenets of the evolutionary synthesis, then, were that populations contain genetic variation that arises by random (i.e. not adaptively directed) mutation and recombination; that populations evolve by changes in gene frequency brought about by random genetic drift, gene flow, and especially natural selection; that most adaptive genetic variants have individually slight phenotypic changes so that phenotypic changes are gradual (although some alleles with discrete effects may be advantageous, as in certain colour polymorphisms); that diversification comes about by speciation, which ordinarily entails the gradual evolution of reproductive isolation among populations; and that these processes, continued for sufficiently long, give rise to changes of such great magnitude as to warrant the designation of higher taxonomic levels (genera, families, and so forth).** (Futuyma, 1987)

Colon (:)

Use a colon:

(i) to separate two parts of a sentence that are in antithesis.

e.g. **“Fair is foul: foul is fair.”**

(ii) to introduce an explanation or a list.

e.g. **The oxidation of organic carbon has a special metabolic function for the heterotroph: it provides energy for growth.**

(It would be correct to insert a colon after **were** in the first line of example (ii) under *Semicolon*.)

Full stop (.)

Use a full stop at the end of a sentence and at the end of abbreviations where the final letter is not the final letter of the full word, *e.g.* Capt. - Captain; *e.g.* - *exemplia gratia*. Compare Dr - Doctor; and wt - weight. An exception to this rule is for abbreviations of SI units, which do not require a full stop (*e.g.* kg - kilogram)

Quotation marks (“...” or ‘...’)

Double or single? Here pragmatism can prevail, and Fowler recommends that you use single quotation marks for a quotation and only use double when a quotation is enclosed in a quotation. Use double quotation marks for spoken text.

Parentheses (Brackets or paired dashes)

Use brackets or paired dashes to insert an illustration, explanation or additional piece of information into a sentence that is logically and grammatically complete without it. Make sure you correctly pair (or close) your brackets or dashes.

e.g. **His distinctive contribution was to show that ‘fixed air’ - namely CO₂ - is taken up by photosynthesis.**

(See also the second example under *Semicolon*.)

(N.B. If you enclose a complete sentence in brackets, place the fullstop inside the closing bracket.) (Use a different bracket type if you enclose a second set of brackets inside the first [as in this example].)

NOTE that parentheses create a pause in a sentence so you do not surround the words enclosed in brackets by commas as well!

Question 4: *Changes in punctuation can markedly alter the meaning of a sentence. To illustrate this, write as many different versions of the following sentence as you can, by changing the punctuation only.*

What is this thing called Love?

There are at least ten possibilities.

(Selected answers available at the Generic Skills Website. Send any more you come up with to Elizabeth.)

Apostrophe

Apostrophe s ('s) denotes possession, not plurality! Use **s'** if the subject that is doing the possessing is plural. *e.g.* **the student's book** (one student), **the students' books** (more than one student). (Note that the **students' book** would be correct if one book were jointly owned by several students.) (Column 8 in the Sydney Morning Herald occasionally records readers' examples of misplaced apostrophes [and other misuses of the English language]). The most common error is to use an apostrophe to denote a simple plural entity, *e.g.* **The student's were protesting in the Main Quad.** is incorrect.

Do not use an apostrophe before the **s** for the plural of acronyms, *e.g.* **CDs** (not CD's), **PCs** (not PC's).

6. PARAGRAPHS

A paragraph is essentially a unit of thought, not of length (Fowler, 1965). Each paragraph should be homogeneous in content and should treat the content in logical and sequential order. There is no general rule about the length of a paragraph and it should be a matter of common sense (that terrible phrase again!). Avoid writing lots of very short paragraphs or excessively long paragraphs. Sensible paragraphing gives your reader a rest and indicates that you are going on to the next point.

A paragraph should be able to stand alone and be understandable independent of the preceding paragraph so do not start a paragraph with **Its ...**, **These ...**, **They ...** or any other pronoun that is defined in the preceding paragraph.

A good way to check that your prose flows logically is to summarise the point of each paragraph with a single sentence or phrase. Check whether the flow is logical, with ideas moving easily from one to another, as you read through the summary. If you follow the principle that a paragraph is homogeneous in content, it should be easy to summarise the guts of it in a phrase or sentence.

7. REFERENCE CITATION

The information you write in any piece of scientific work could come from one of several sources: your own mind or experience; a written source such as a journal paper or textbook; or the words or experience of a colleague, tutor or lecturer. If you include any facts or ideas obtained from any place other than your own head or analysis of your own data, you **MUST** indicate the original source.

Written works

The name-and-year system (or Harvard system) of citation is most commonly used in biological journals and you will be required to use this system in all your written work. Some journals use a numbering system but this is normally due to space limitations and is not acceptable for assignment or thesis work.

Choose a logical point within your sentence to write in brackets the surname of the author(s) and the year of publication of the journal or book. Placing a comma between the author and year is optional (but should be consistent within any one manuscript).

e.g. **Anaerobic fungi extensively colonise plant material in rumen digesta (Bauchop, 1979).**

Citations and punctuation

If the author's name forms part of the sentence, write the year in brackets. **NOTE** that any punctuation mark is placed after the closing bracket. This rule also applies to any other stop in the sentence (comma, semicolon or colon).

e.g. **The role of brown adipose tissue in the increased heat production of cold-acclimated rats was clearly demonstrated by the blood flow studies of Foster and Frydman (1979).**

Two authors

Write both names separated by **and** (or **&**).

e.g. **Thermogenesis in cold-exposed placental mammals involves heat generated by muscle and brown adipose tissue (Foster and Frydman, 1979).**

Three or more authors

Write the first author, followed by *et al.*, which stands for *et alia* (= and others).

e.g. **The synergistic action of three enzymes is necessary for sufficient breakdown of cellulose in the termite, *Macrotermes mulleri* (Rowland *et al.*, 1988).**

(Note that *et al.* (i) is italicised (or underlined) because it is Latin; and (ii) ends with a full stop because the last letter of the abbreviation is not the same as the last letter of the full word.)

* Do NOT include a page number in a reference citation. A page number is only required for direct quotations, which, you recall, should be **avoided**).

* The **full reference** for every citation (including surnames and initials of all authors) should appear in your reference list (called References, References Cited, or Literature Cited but NEVER Bibliography). Note carefully how each reference is written in the reference lists in your course manuals and in the scientific papers you read.

* If you cite articles written in **foreign languages** you must indicate, in your reference list, whether you are citing the original article, a translation or an abstract.

DO NOT USE FOOTNOTES to list references. And do not use *ibid.* - you must write the reference citation each time you use the reference.

* In instances where you have cited several different publications by the same author in the same year: these are cited in the text as (Smith, 1980a), (Smith, 1980b), *etc.* and are listed in the order a, b, *etc.* in your reference list.

Unseen references

You should **avoid** citing references that you have not read. If it is really unavoidable (*e.g.* if the original paper cannot be found or is in a foreign language) then you must cite both the original work and the reference in which you found the cited material.

e.g. **The French strain of the parasite *Trioxys pallidus* was not effective in reducing numbers of the walnut aphid (van den Bosch & Messenger, 1971, in Dixon, 1977).**

This example indicates that you read the reference by Dixon (1977), in which the author cited the reference by van den Bosch & Messenger (1971). The complete details of both references should appear in your reference list. Be warned that more than two such citations in any submitted work will be viewed with grave suspicion!

Direct quotations

Direct quotations should also be **avoided**. If you cannot paraphrase an author's work and feel that only a direct quotation will do the job, you should enclose the quoted section in single quotation marks (unless you are quoting speech, in which case you use double quotation marks). Place any comma or full stop inside the closing quotation mark but place any colon (:) or semicolon (;) outside the closing quotation mark. Include the page number in the reference citation (ONLY for direct quotations). If you omit a section of the original quotation, indicate this with three full stops (ellipsis marks) and if you insert your own words to clarify anything within the quotation, indicate this by square brackets. Be careful that you do not change the author's meaning when you do this.

e.g. **‘[One] case for regarding the ... Mollusca as being derived from the turbellarian-rhynchocoel phyla ... hinges on the conclusion that metameric segmentation ... does not occur in primitive molluscs.’ (Russell-Hunter, 1979, p 618)**

Verbal references

If you use information that another person told you, cite the initials and surname of the person, followed by **pers. comm.** (for ‘personal communication’). This is often used in journal papers to include unpublished results passed on to the author from another person.

e.g. **Preliminary experiments have shown the insecticide to have no significant effect on genetic mutants of *Drosophila* (W. N. Bingle, pers. comm.).**

Plagiarism

If you use the words or work of another person without citation or proper quotation you are guilty of **plagiarism** and at University this amounts to a charge of **academic misconduct**. A charge of academic misconduct can result in **exclusion of a student from the University for up to two years**. The charge of plagiarism and academic misconduct extends to use of another student's work.

8. REFERENCE LIST

The **full reference** for every citation (including surnames and initials of ALL authors) should appear in your reference list (called References, References Cited, or Literature Cited but NEVER Bibliography). Note carefully how each reference is written in the reference lists in your course manuals and in the scientific papers you read.

List references in alphabetical order according to first author. Do not re-arrange the order of authors within a reference. (The order usually indicates the relative contribution of each author to the work.) Each reference must give the reader all the information required to find the original paper or monograph. When you use any reference, even if you make only a few brief notes from it, record the full reference at the same time. It is extremely irritating to have to relocate the journal just to find out such details as the page numbers. Writing each reference onto a file card is a convenient method of keeping track and it is then a simple matter to order the appropriate cards alphabetically to compile your reference list. (Alternatively use a reference database program such as Endnote.)

Titles of journals are normally abbreviated and there is an international convention for this. The accepted abbreviation is usually printed as a header on the first page or every page of the paper. If in doubt, write the full journal name. Abbreviations for the names of common journals are listed in the *World List of Scientific Periodicals* and *Sources for the Biosis Data Base*, which are available in Fisher and Badham libraries.

Examples of references and their text citations

TYPE OF PUBLICATION	EXAMPLE
<p><u>Journal paper</u></p> <p>Surnames and initials of <u>all</u> authors (Year of publication) Full title of paper. <u>Name and volume number of journal:</u> Page numbers of paper.</p>	<p>Weider, R. K. and Lang, G. E. (1982) A critique of the analytical methods used in examining decomposition data obtained from litter bags. <u>Ecology</u> 63 : 1636 - 1642. Text citation: (Weider and Lang, 1982)</p>
<p><u>Monograph (book)</u></p> <p>Surnames and initials of all authors (Year of publication) Full title of book. Number of edition (if there is more than one) (Publisher : City or Town of Publication)</p>	<p>Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (1996) An introduction to genetic analysis. 6th edition. (W.H. Freeman: New York) Text citation: (Griffiths <i>et al.</i>, 1996)</p>

<p><u>Paper or chapter in a monograph</u></p> <p>Surnames and initials of all authors (Year of publication) Full title of paper or chapter. (In) Title of book (Eds Initials and surnames of all editors) Page numbers of paper or chapter (Publisher : City or Town of Publication)</p>	<p>Savage, J. M. (1982) The geographic distribution of frogs: patterns and predictions. (In) Evolutionary biology of the Anurans. (Ed. J. L. Vial) pp 351 - 445 (University of Missouri Press : Columbia)</p> <p>Text citation: (Savage, 1982)</p> <p><i>(Note that Editor abbreviates to Ed. (fullstop) and Editors abbreviates to Eds (no fullstop). Note also the position of initials and surnames for editors.)</i></p>
<p><u>Thesis</u></p> <p>Surname and initials of author (Year of submission of the thesis) Title of thesis. Degree for which the thesis was submitted. Name of University</p>	<p>Wannan, B. (1986) Systematics of the Anarcadiaceae and its allies. Ph. D. University of N.S.W.</p> <p>Text citation: (Wannan, 1986)</p>

Publishers vary in the conventions required for typesetting and punctuating references, *e.g.* presence or absence of bracketing, commas, fullstops after author initials, italicising, bold type, underlining, *etc.* Provided all the required information is present and you are consistent within the one work, you may go with your own preference for punctuating references in essays and assignments. Compare the reference lists in a variety of publications to see the range of conventions. Placing brackets around the year and placing the year immediately after the author(s) does make it easier to read.

So, how do you translate the information in a title page or journal page into a correct reference listing?

For a **monograph**, the date is the year of copyright, which is usually printed on the page after the title page. If there is more than one edition of the book, include the edition number in the title and make sure the date you cite is the correct copyright date for that edition. For a **paper or chapter in a book**, make sure you record the author(s) of the paper or chapter, the first and last page numbers, and the full title, editors and publication details of the book. For a **journal article**, the abbreviated journal title, volume number and page numbers are usually written in a header or footer on each page. (If not, record all this information when you photocopy the article!)

Publication details

If the place of publication or location of a University may not be well known, include either the city, state or country as necessary, *e.g.* (Prentice Hall: Englewood Cliffs, New Jersey); (Bond University: Queensland, Australia). Do not include Co., Pty Ltd, Inc., & Sons, *etc.* in the name of a publisher. Note that U.S.A., U.K. or Aust. are not sufficient to indicate the place of publication! Do not confuse the place of publication with the city where the publication was typeset and printed: they usually differ. Some publishers may have several towns or cities listed on the title page; the place of publication is the first town or city listed and the address of that office is usually printed on the next page.

References (cited in text above)

Gopen, G.D. and Swan, J.A. (1990) The science of scientific writing. *Amer. Scientist* 78: 550-558

Towns, P. (1990) Is literacy important? *Aust. Biochem. Soc. Newsletter* 3: 21

Woods, A. (1989) English Tutorial notes. University of NSW

Useful student references

Pocket guides to English

1. Hardie, R. G. (1990) **Collins Gem English grammar**. (Eds P. Hanks and A. Grandison) (Collins: Glasgow)
2. Weiner, E. S. C. (1983) **The Oxford miniguide to English usage**. (Oxford University Press: Oxford) (*Fisher 423/99*)

General writing style and word usage

1. Australian Government Publishing Service (1995) **Style manual for authors, editors and printers**. 5th edition. (AGPS Press: Canberra) (*Badham reference; Fisher 808.041 101 F*)
2. Fowler, H. W. (1965) **A dictionary of modern English usage**. Second edition. Revised by Sir Ernest Gowers. (Oxford University Press: Oxford) (reprinted also 1968, 1983) (*Fisher 428/13D*) (The 3rd edition, edited by R.W. Burchfield, was published in 1996.)
4. Hudson, N. (1993) **Modern Australian usage**. (Oxford University Press: Melbourne) (*Fisher Reference 428.00994/3 Not for Loan*)

Scientific writing

1. Council of Biology Editors, Committee on form and style. (1983) **CBE Style Manual**. 5th edition. (American Institute of Biological Sciences: Washington) (*Badham 808.02 69*)
2. Lindsay, D. (1984) **A guide to scientific writing**. (Longman Cheshire: Melbourne)
3. O'Connor, M (1991) **Writing successfully in science**. (Chapman Hall: London) (*Health Sciences 808.0665 OCO*)

Sentence: a group of words that contains a subject and a verb that directly relates to that subject. A sentence may consist of a single clause (simple sentence) or two or more clauses (compound or complex sentence).

- e.g. (simple) The cricket ball shattered the window.
(compound) We went to Adelaide and visited the Barossa valley.
(complex) We travelled through Victoria, which was dry and dusty.

Clause: a group of words that contains a verb, the subject of the verb and often the object of the verb.

- e.g. The insecticide killed the flies ...
(subject) (verb) (object)

Two clauses in the one sentence can be joined by a coordinating conjunction (e.g. and, but, neither, nor, yet). In this case the two clauses are of equal importance.

- e.g. The insecticide killed the flies and retarded metamorphosis of the pupae.
(main clause) (main clause)

(It is not necessary to repeat the subject. However, if the sentence were separated into two sentences, then the subject [or its pronoun] should appear in the second sentence.)

When a clause is preceded by a subordinate conjunction (e.g. that, which, who, since, because, when, if) it becomes a subordinate clause. A subordinate clause cannot exist on its own as a sentence!

- e.g. When applied in sufficient concentration, the insecticide killed the flies.
(subordinate clause) (main clause)

A defining (restrictive) clause defines a noun and limits the possible reference of the noun. It is never separated from the noun by a comma!

- e.g. The flies that were not killed by the insecticide were naturally resistant.
(The defining clause defines a particular set of flies - those that were not killed by the insecticide.)

A non-defining (non-restrictive) clause simply gives more information about a noun, without limiting its possible reference. It is always separated from the main clause by commas.

- e.g. The flies, which were bred at CSIRO, were naturally resistant to insecticide.
(The non-defining clause simply gives additional information about the flies.)

- Compare: (defining) The brother who lives in Canberra is a doctor.
(There are several brothers. The one living in Canberra is a doctor.)
(non-defining) The brother, who lives in Canberra, is a doctor.
(There is one brother. He is a doctor. He lives in Canberra.)